

Grewia kentingensis (Malvaceae, Grewioideae), a new species from Taiwan

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Abstract

Grewia kentingensis Y.H. Tseng, Chih Y.Chang & C.Y.Lin, **sp. nov.**, a new species found on elevated coral reefs in southern Taiwan, is described. The species was previously misidentified as *G. piscatorum* Hance. *Grewia kentingensis* differs from *G. piscatorum* in its habit (procumbent vs. erect to ascending shrub), leaf length (<2 cm vs. up to 7 cm), breeding system (gynodioecious vs. trioecious), smaller flower diameter, fewer stamens, and smaller pollen grains. Color photographs, line drawings, and pollen images of the new species are provided. Additionally, a lectotype for *G. piscatorum* is designated and an identification key for the *Grewia* taxa of Taiwan is presented.

Key words: Critically endangered, *Grewia piscatorum* Hance, pollen morphology, southern Taiwan, taxonomy



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Introduction

Grewia L. (Malvaceae: Grewioideae) is comprised of 280–300 species, which are distributed in the Old World tropics (Chung et al. 2003, 2005; Randrianasolo et al. 2013). The genus includes trees, shrubs, and climbers, which are characterized by leaves that are 3- to 5-nerved from the base; solitary, cymose, or umbellate inflorescences that are axillary, leaf-opposed, or terminal; and numerous free stamens, an androgynophore, and unlobed or 2- to 4-lobed drupaceous fruits (Liu and Lo 1993; Kubitzki and Bayer 2003; Tang et al. 2007). According to Liu and Lo (1993), four species have been recorded in Taiwan; *G. biloba* G. Don, *G. eriocarpa* Juss., *G. piscatorum* Hance, and *G. rhombifolia* Kaneh. & Sasaki. Chang et al. (2018) later reported an occurrence of *G. tiliifolia* Vahl.

On the basis of floral and fruit morphology, Burret (1926) subdivided *Grewia* into four sections but his classification system is probably artificial (Dorr, pers. comm.). Nonetheless, the Taiwanese taxa can be placed in two of Burret's sections. *Grewia eriocarpa* and *G. tiliifolia*, which are characterized by axillary inflorescences, bisexual flowers, entire stigmas lobes, and often unlobed fruits, can be assigned to sect. *Axillares* Burret while *G. biloba*, *G. piscatorum*, and *G. rhombifolia*, characterized by leaf-opposed, terminal, or rarely axillary inflorescences, unisexual or bisexual flowers, stigmas lobes with filamentary divisions,

and usually 4-lobed fruits can be assigned to sect. *Glomeratae* Burret (see also Chang et al. 2018).

During recent field and herbarium investigations, we noticed that populations of *Grewia* growing on elevated coral reefs in Hengchun Peninsula, Taiwan had been identified as *G. piscatorum* based on sparse hairs on both leaf surfaces and white sepals. However, individuals in this locality diverged from *G. piscatorum* in several characters, including their procumbent habit, smaller stipules, leaves with fewer serrations, smaller flowers, shorter pedicels, and fewer stamens. After careful comparison, we concluded that the material from Hengchun represents a new species, which is described here as *G. kentingensis*.

Materials and methods

Morphological comparison

We compared our unknown taxon to *Grewia piscatorum*. Additionally, we compared it to the Taiwanese taxa *G. rhombifolia* and *G. biloba* var. *biloba* as well as to the non-Taiwanese taxa *G. biloba* var. *parviflora* (Bunge) Hand.-Mazz. and *G. biloba* var. *microphylla* (Maxim.) Hand.-Mazz., all of which can be assigned to sect. *Glomeratae*. Morphological measurements were conducted using both fresh and dried material. Quantitative characters were measured using fresh material, while dry specimens only were used for qualitative character observations and descriptions. For each taxon, at least three individuals were used for measurements and statistical tests. Morphological descriptions follow Liu and Lo (1993); Wahlert et al. (2015); and Barrett (2019).

Herbarium resources

Herbarium acronyms from Index Herbariorum were used in this study (Thiers 2024, continuously updated). Voucher specimens collected for the current study were deposited in the herbarium of the Department of Forestry, National Chung Hsing University, Taiwan (TCF). Physical and digital specimens in several herbaria also were examined; physical specimens: Department of Forestry and Natural Resources, National Chia-Yi University, Taiwan (CHIA), Provincial Pingtung Institute (PPI), National Taiwan University, Taiwan (TAI), Endemic Species Research Institute, Taiwan (TAIE), Taiwan Forestry Research Institute (TAIF), TCF, and National Museum of Natural Science, Taiwan (TNM); and digital specimens: School of Life Sciences, Xiamen University (AU), The Natural History Museum (BM), South China Botanical Garden, Chinese Academy of Sciences (IBSC), and the Royal Botanic Gardens, Kew (K).

Pollen morphology

Pollen grains were acetolyzed following the method established by Erdtman (1960). Grains were sequentially dehydrated in ethanol and then critical point dried. The dried pollen grains were mounted on a stub and sputter-coated with gold in a Quorum SC7620 sputter coater (Quorum Technologies, Laughton, UK) for 120 s. Subsequently, the grains were observed under a Hitachi S-3400N scanning electron microscope (Hitachi, Ltd, Tokyo, Japan). At least thirty pollen

Table 1. Voucher material for the *Grewia* L. pollen morphology.

Taxon	Location	Coordinate	Altitude	Date	Voucher
<i>G. kentingensis</i>	TAIWAN. Pingtung County, Hengchun Township, Fongchueisha	21°56'57.8"N, 120°50'16.5"E	73 m	3 May 2024	<i>C. Y. Lin et al.</i> 69 (TCF)
	TAIWAN. Pingtung County, Hengchun Township, Shedding Formosan Sika Deer Restoration Area	21°57'53.0"N, 120°49'39.2"E	154 m	26 June 2024	<i>C. Y. Lin et al.</i> 93 (TCF)
<i>G. piscatorum</i>	TAIWAN. Kinmen County, Jincheng Township, Zhaishan Tunnel	24°23'20.0"N, 118°19'07.1"E	20 m	25 May 2024	<i>C. Y. Lin et al.</i> 80 (TCF)
	TAIWAN. Kinmen County, Jinsha Township, Mashan Observation Post	24°31'39.3"N, 118°24'37.9"E	4 m	29 May 2023	<i>C. Y. Lin</i> 24 (TCF)
	TAIWAN. Lienchiang County, Nangan Township, Guanmaoshan	26°08'23.7"N, 119°55'44.3"E	15 m	13 June 2023	<i>C. Y. Lin</i> 26 (TCF)
<i>G. rhombifolia</i>	TAIWAN. New Taipei City, Wanli Dist., Yehliu Geopark	25°12'32.2"N, 121°41'38.2"E	1 m	22 April 2023	<i>C. Y. Lin et al.</i> 7 (TCF)
	TAIWAN. New Taipei City, Ruifang Dist., Nanyaqiyang	25°07'11.4"N, 121°53'33.1"E	2 m	12 May 2024	<i>C. Y. Lin</i> 79 (TCF)
	TAIWAN. New Taipei City, Ruifang Dist., Bat cave park	25°07'39.2"N, 121°50'05.1"E	4 m	27 June 2024	<i>C. Y. Lin</i> 96 (TCF)
<i>G. biloba</i> var. <i>biloba</i>	TAIWAN. Hualien County, Xiulin Township, Chongde trail	24°11'34.4"N, 121°39'45.3"E	24 m	26 March 2023	<i>C. Y. Lin</i> 6 (TCF)
	TAIWAN. Kaohsiung City, Mituo Dist., Ta-di Mountain Natural Park	22°46'05.8"N, 120°14'58.7"E	47 m	23 July 2023	<i>C. Y. Lin</i> 31 (TCF)
	TAIWAN. Pingtung County, Chunri Township, Dahan forest road	22°25'13.0"N, 120°40'51.4"E	953 m	11 August 2024	<i>C. Y. Lin</i> 105 (TCF)

grains were observed and measured for each taxon. The terminology for the morphological descriptions of pollen grains is in accordance with the terminology used by Erdtman (1952) and Halbritter et al. (2018). Information on voucher specimens is provided in Table 1.

Distribution map

A distribution map for this species was generated using QGIS ver. 3.24.2 (QGIS.org 2024) with the package developed by Lin (2018).

Data analysis

Quantitative morphological characters of taxa were measured and means and standard deviations were calculated (Table 2). Differences among taxa were analyzed using one-way analysis of variance, followed by Tukey’s Honestly Significant Difference (HSD) multiple-range test ($p \leq 0.05$) (Oliveira 2013). All statistical analyses were conducted using SPSS ver. 20 (Jasrai 2020).

Results and discussion

Macromorphological differences

Grewia kentingensis can be assigned to sect. *Glomeratae* in the infrageneric classification system proposed by Burret (1926), as can *G. piscatorum*, *G. rhombifolia*, and *G. biloba* var. *biloba*. The species assigned to sect. *Glomeratae* in Taiwan have three different habits: 1) *G. biloba* var. *biloba* is a small tree that is ca. 3–5 m tall and usually has a distinct main trunk, 2) *G. piscatorum* and *G.*

rhombifolia are erect to ascending shrubs 1–2 m tall, 3) *G. kentingensis* is a procumbent shrub that is clearly distinct from other taxa (Fig. 1, Table 2). Both leaf surfaces in *G. rhombifolia* are densely covered with stellate hairs, whereas both leaf surfaces in *G. kentingensis*, *G. piscatorum*, and *G. biloba* var. *biloba* are nearly glabrous (Table 2). The leaf blades of *Grewia* taxa in Taiwan have distinct shapes: *G. kentingensis* has broadly elliptic to elliptic leaves, *G. piscatorum* displays elliptic, obovate, ovate, and rhomboid-ovate leaves, *G. biloba* var. *biloba* features ovate, elliptic, and rhomboid-ovate leaves, and *G. rhombifolia* has rhomboid, broadly rhomboid, and obtrullate leaves (Table 2). Among the *Grewia* taxa in Taiwan, *G. kentingensis* has the smallest leaves ($p \leq 0.05$). The leaves of *G. kentingensis* measure $0.4\text{--}1.6 \times 0.3\text{--}1.3$ cm. The leaves of *G. piscatorum* measure $0.7\text{--}7.8 \times 0.5\text{--}5.5$ cm. The leaves of *G. rhombifolia* measure $1.6\text{--}6.7 \times 1.1\text{--}7.0$ cm. The leaves of *G. biloba* var. *biloba* measure $2.1\text{--}13.9 \times 1.3\text{--}7.4$ cm (Table 2). *Grewia piscatorum* exhibits considerable variation in leaf size, partially overlapping with *G. kentingensis* (Table 2). The leaf margin in *G. kentingensis* is serrate, and that of *G. piscatorum* and *G. biloba* var. *biloba* are serrulate to biserrulate. The leaf margin in *G. rhombifolia* is irregularly serrulate or biserrulate to dentate. *Grewia kentingensis* features significantly fewer leaf serrations (9–20) ($p \leq 0.05$) than *G. piscatorum* (23–82), *G. rhombifolia* (26–88), or *G. biloba* var. *biloba* (29–132) (Table 2).

Significant differences also were observed in the length of peduncles and pedicels among the *Grewia* taxa measured ($p \leq 0.05$). *Grewia kentingensis* features significantly shorter peduncles and pedicels (peduncles: 0.7–2.7 mm, pedicels: 0.9–4.9 mm) ($p \leq 0.05$) compared with *G. piscatorum* (peduncles: 3.1–17.2 mm, pedicels: 3.5–8.8 mm), *G. rhombifolia* (peduncles: 3.0–13.1 mm, pedicels: 3.8–8.6 mm), and *G. biloba* var. *biloba* (peduncles: 3.7–14.3 mm, pedicels: 4.4–9.3 mm) (Table 2). Regarding the sexual or breeding system, *G. kentingensis* is gynodioecious, whereas the other taxa are all trioecious (Table 2). Flower diameter in *G. kentingensis* (7.2–11.7 mm in bisexual flowers and 5.2–7.8 mm in female flowers) is significantly smaller ($p \leq 0.05$) than it is in *G. piscatorum* (14.8–18.5 (–20.2) mm in bisexual flowers and 9.4–14.6 mm in female flowers), *G. rhombifolia* (13.9–17.8 mm in bisexual flowers and 8.9–13.8 mm in female flowers), or *G. biloba* var. *biloba* (13.9–18.7 mm in bisexual flowers and 8.8–11.3 mm in female flowers) (Table 2). Moreover, the sepals and petals in *G. kentingensis* are notably shorter than those in *G. piscatorum*, *G. rhombifolia*, or *G. biloba* var. *biloba* (Table 2). *Grewia kentingensis* also features significantly fewer stamens (25–34 in bisexual flowers and 14–23 in female flowers) ($p \leq 0.05$) compared with *G. piscatorum* (103–118 in bisexual flowers and 58–102 in female flowers), *G. rhombifolia* (64–103 in bisexual flowers and 51–80 in female flowers), and *G. biloba* var. *biloba* (65–121 in bisexual flowers and 55–98 in female flowers) (Table 2). Additionally, the filaments and styles of bisexual flowers in *G. kentingensis* are significantly shorter ($p \leq 0.05$) than those in other taxa (Table 2).

Finally, although all the taxa assigned to sect. *Glomeratae* in Taiwan exhibit 4-lobed fruits with nearly glabrous surfaces that turn red after maturation, drupelet size in *Grewia kentingensis* (4.1–5.2 mm) is significantly smaller ($p \leq 0.05$) than those in *G. piscatorum* (4.4–6.4 mm), *G. rhombifolia* (4.7–6.3 mm), or *G. biloba* var. *biloba* (4.5–5.6 mm) (Table 2).

Other taxa that are morphologically similar to *Grewia kentingensis* and assigned to sect. *Glomeratae* but not found in Taiwan include *G. biloba* var. *parviflo-*

Table 2. Summary of diagnostic characters of *Grewia* sect. *Glomeratae* Burret in Taiwan.

Characters		<i>G. kentingensis</i>	<i>G. piscatorum</i>	<i>G. rhombifolia</i>	<i>G. biloba</i> var. <i>biloba</i>
Habit		procumbent shrub, ca. 5 cm tall	erect to ascending shrub, ca. 1–2 m tall	erect to ascending shrub, ca. 1–2 m tall	small tree, ca. 3–5 m tall
Leaves					
shape		broadly elliptic to elliptic	elliptic, obovate, ovate to rhomboid-ovate	rhomboid, broadly rhomboid to obtrullate	ovate, elliptic to rhomboid-ovate
size (cm)		0.76 ± 0.28 ^c × 0.60 ± 0.25 ^c	3.93 ± 1.82 ^b × 2.67 ± 1.31 ^b	4.12 ± 1.32 ^b × 3.01 ± 1.23 ^b	6.56 ± 2.36 ^a × 3.64 ± 1.26 ^a
margin		serrate	serrulate to biserrulate	irregularly serrulate, biserrulate to dentate	serrulate to biserrulate
surfaces		Both surfaces nearly glabrous	Both surfaces nearly glabrous	Both surfaces densely covered with stellate hairs	Both surfaces nearly glabrous
number of serrations		13.83 ± 2.57 ^c	47.87 ± 16.00 ^b	49.69 ± 17.66 ^b	65.48 ± 24.75 ^a
stipule length (mm)		0.78 ± 0.19 ^b	3.84 ± 0.73 ^a	3.99 ± 0.60 ^a	4.02 ± 0.79 ^a
Sexual system		Gynodioecy	Trioecy	Trioecy	Trioecy
Inflorescences					
position		terminal	leaf-opposed, rarely axillary	leaf-opposed, rarely axillary	leaf-opposed, rarely axillary
per inflorescence flower number		2.39 ± 1.17 ^c	9.49 ± 2.63 ^a	7.41 ± 2.01 ^b	8.42 ± 2.19 ^{ab}
peduncle length (mm)		1.49 ± 0.60 ^b	6.63 ± 2.61 ^a	6.90 ± 2.64 ^a	7.87 ± 2.19 ^a
pedicel length (mm)		2.59 ± 1.21 ^b	6.05 ± 1.46 ^a	6.23 ± 1.35 ^a	6.57 ± 1.50 ^a
Flowers					
flower diameter (mm)	Bisexual flower	9.49 ± 1.34 ^c	16.88 ± 1.71 ^a	15.39 ± 1.22 ^b	16.25 ± 1.52 ^{ab}
	Female flower	6.75 ± 0.84 ^c	11.65 ± 1.29 ^a	11.49 ± 1.23 ^a	10.09 ± 0.75 ^b
sepal number		(3)4–5	(4)5(6)	(4)5(6)	(4)5(6)
sepal size (mm)	Bisexual flower	5.34 ± 0.46 ^c × 1.84 ± 0.27 ^c	8.70 ± 0.83 ^a × 3.03 ± 0.44 ^a	8.15 ± 0.73 ^b × 2.54 ± 0.43 ^b	7.89 ± 0.57 ^b × 2.46 ± 0.27 ^b
	Female flower	3.94 ± 0.49 ^c × 1.29 ± 0.23 ^c	5.09 ± 0.34 ^b × 1.63 ± 0.13 ^a	5.47 ± 0.46 ^a × 1.51 ± 0.13 ^b	5.12 ± 0.46 ^b × 1.62 ± 0.12 ^{ab}
petal size (mm)	Bisexual flower	1.32 ± 0.13 ^d × 0.75 ± 0.08 ^c	2.65 ± 0.28 ^a × 1.01 ± 0.08 ^a	2.32 ± 0.24 ^b × 1.00 ± 0.06 ^a	1.79 ± 0.19 ^c × 0.92 ± 0.11 ^b
	Female flower	1.37 ± 0.10 ^c × 0.79 ± 0.07 ^a	1.93 ± 0.24 ^a × 0.78 ± 0.13 ^a	1.64 ± 0.20 ^b × 0.78 ± 0.12 ^a	1.87 ± 0.53 ^a × 0.86 ± 0.20 ^a
stamens number	Bisexual flower	29.88 ± 3.09 ^c	110.86 ± 4.93 ^a	82.89 ± 15.88 ^b	87.09 ± 18.74 ^b
	Female flower	17.55 ± 2.58 ^c	79.53 ± 12.30 ^a	64.77 ± 8.18 ^b	80.67 ± 19.16 ^a
filaments length (mm)	Bisexual flower	1.92 ± 0.56 ^b	4.02 ± 0.96 ^a	3.87 ± 1.16 ^a	3.61 ± 0.83 ^a
	Female flower	0.76 ± 0.12 ^c	1.00 ± 0.27 ^{ab}	0.90 ± 0.28 ^{bc}	1.05 ± 0.37 ^a
style length (mm)	Bisexual flower	2.44 ± 0.32 ^c	4.18 ± 0.58 ^a	3.65 ± 0.22 ^b	3.71 ± 0.53 ^b
	Female flower	1.83 ± 0.28 ^c	2.25 ± 0.22 ^{ab}	2.46 ± 0.21 ^a	2.02 ± 0.24 ^{bc}
Druplet size (mm)		4.60 ± 0.22 ^b	5.39 ± 0.50 ^a	5.43 ± 0.45 ^a	5.11 ± 0.36 ^a
Pollen					
polar axis (µm)		37.61 ± 1.62 ^b	45.32 ± 1.34 ^a	45.93 ± 1.65 ^a	44.65 ± 1.27 ^a
equatorial axis (µm)		28.35 ± 2.47 ^{bc}	29.07 ± 1.05 ^{ab}	29.90 ± 1.38 ^a	26.89 ± 1.74 ^c
P/E ratio		1.33 ± 0.10 ^c	1.56 ± 0.06 ^b	1.54 ± 0.11 ^b	1.67 ± 0.11 ^a
shape		subprolate to prolate	prolate	prolate	prolate
lumen size (µm)		1.98 ± 0.56 ^b	2.47 ± 0.77 ^a	2.40 ± 0.53 ^a	2.24 ± 0.72 ^{ab}
muri width (µm)		0.68 ± 0.06 ^a	0.56 ± 0.09 ^b	0.55 ± 0.07 ^b	0.54 ± 0.06 ^b
perforation size (µm)		0.11 ± 0.05 ^a	0.11 ± 0.06 ^a	0.11 ± 0.06 ^a	0.12 ± 0.08 ^a
Distribution		Endemic to Taiwan; restricted to elevated coral reefs and coastal grasslands of the eastern coast of Hengchun Peninsula.	Distributed along the coast in Fujian and Hainan provinces in China. In Taiwan, found in Kinmen and Lienchiang counties.	Endemic to Taiwan; distributed along the coast and hills of northern to central Taiwan.	Distributed in central and southern China. At altitudes of ca. 10–1000 m in southern and eastern Taiwan.

^{abcd} Means in the same row followed by the same letter are not significantly different ($p \leq 0.05$; Tukey's HSD test).



Figure 1. Habit of taxa assigned to *Grewia* sect. *Glomeratae* Burret in Taiwan. **A** *Grewia kentingensis* Y.H.Tseng, Chih Y.Chang & C.Y.Lin **B** *Grewia piscatorum* Hance **C** *Grewia rhombifolia* Kaneh. & Sasaki **D** *Grewia biloba* G. Don var. *biloba*.

ra, which is distributed from northern to southern China and the Korean Peninsula (Chang 1989; Tang et al. 2007; Chang et al. 2014) and *G. biloba* var. *microphylla*, which is distributed in Sichuan and Yunnan provinces in China (Chang 1989; Wu et al. 1995; Tang et al. 2007). They all exhibit common characteristics such as white sepals, unisexual or bisexual flowers, and 4-lobed drupes that turn red upon maturation (Chang 1989; Tang et al. 2007). However, these two varieties are shrubs or trees 1–4-m tall (Chang 1989; Tang et al. 2007), whereas *G. kentingensis* is a procumbent shrub (Table 3). In addition, *G. kentingensis* can be readily dis-

Table 3. Summary of diagnostic characters of *Grewia kentingensis* Y.H.Tseng, Chih Y.Chang & C.Y.Lin and two non-Taiwanese species of sect. *Glomeratae* Burret.

Characters	<i>G. kentingensis</i>	<i>G. biloba</i> var. <i>microphylla</i> ^a	<i>G. biloba</i> var. <i>parviflora</i> ^b
Habit	procumbent shrub, ca. 5 cm tall	shrub or tree, ca. 1–4 m tall	shrub or tree, ca. 1–4 m tall
Leaves			
shape	broadly elliptic to elliptic	ovate	ovate
size (cm)	0.4–1.6 × 0.3–1.3	1.0–2.5 × 0.9–1.5	3.0–11.5 × 2.0–7.0
margin	serrate	biserrulate	biserrulate
surfaces	Both surfaces nearly glabrous	adaxial surface nearly glabrous, abaxial surface covered with stellate hairs	adaxial surface nearly glabrous, abaxial surface covered with stellate hairs
Inflorescences	solitary to cyme	umbel	umbel
Adaxial surface of petals	glabrous	tomentose	glabrous
Distribution	Endemic to Taiwan; restricted to elevated coral reefs and coastal grasslands of the eastern coast of Hengchun Peninsula.	Distributed in Sichuan and Yunnan provinces in China.	Distributed in northern to southern China and the Korean Peninsula.

^a Character states from Maximowicz (1889), Chang (1989) and Tang et al. (2007).

^b Character states from Bunge (1835), Chang (1989) and Tang et al. (2007).

tinguished from *G. biloba* var. *parviflora* by its broadly elliptic to elliptic (vs. ovate) leaf blade shape, smaller leaf blade size (0.4–1.6 × 0.3–1.3 cm vs. 3.0–11.5 × 2.0–7.0 cm), nearly glabrous (vs. abaxial surface covered with stellate hairs) leaf surfaces, and solitary to cymose (vs. umbellate) inflorescences (Bunge 1835; Chang 1989; Tang et al. 2007) (Table 3). The leaf blade size in *G. biloba* var. *microphylla* is smaller (1.0–2.5 × 0.9–1.5 cm), and its range overlaps with that of *G. kentingensis* (0.4–1.6 × 0.3–1.3 cm) (Table 3). *Grewia biloba* var. *microphylla* has ovate leaf blades with an acute to obtuse apex, stellate hairs covering the abaxial surface of leaves, and tomentum on the adaxial surface of its petals (Maximowicz 1889; Chang 1989; Tang et al. 2007). *Grewia kentingensis* features broadly elliptic to elliptic leaf blades with a rounded to obtuse apex, nearly glabrous leaf surfaces, and glabrous adaxial surface on its petals (Table 3).

Pollen morphology

Pollen grains of taxa assigned to sect. *Glomeratae* in Taiwan are medium-sized and tricolporate, subprolate, or prolate (Fig. 3, Table 2). These observations are consistent with those provided by Huang (1972) and Hsieh and Huang (1983). *Grewia kentingensis* has a significantly shorter polar axis ($p \leq 0.05$) (35.8–41.4 µm) than *G. piscatorum* (42.8–47.8 µm), *G. rhombifolia* (42.8–48.2 µm), or *G. biloba* var. *biloba* (42.5–46.9 µm) (Fig. 3, Table 2). The P/E ratio in *G. kentingensis* is the smallest (1.1–1.5) and is significantly lower ($p \leq 0.05$) than that in the other species (Fig. 3, Table 2). In addition, pollen grains of *G. kentingensis* are subprolate to prolate in shape, whereas those of the other taxa are prolate (Fig. 3, Table 2). The exine in all these taxa is reticulate, with perforations in the lumen (Fig. 3). Perforation size is not significantly different among the four species (Fig. 3, Table 2). Lumen size in *G. kentingensis* (1.0–2.9 µm) is significantly smaller ($p \leq 0.05$) than that in *G. piscatorum* (1.1–4.0 µm) or *G. rhombifolia* (1.4–3.5 µm). However, no significant difference was observed in the lumen size between *G. kentingensis* and *G. biloba* var. *biloba* (1.1–3.6 (–4.0) µm) (Fig. 3, Table 2). Muri width in *G. kentingensis* (0.6–0.8 µm) is significantly larger ($p \leq$

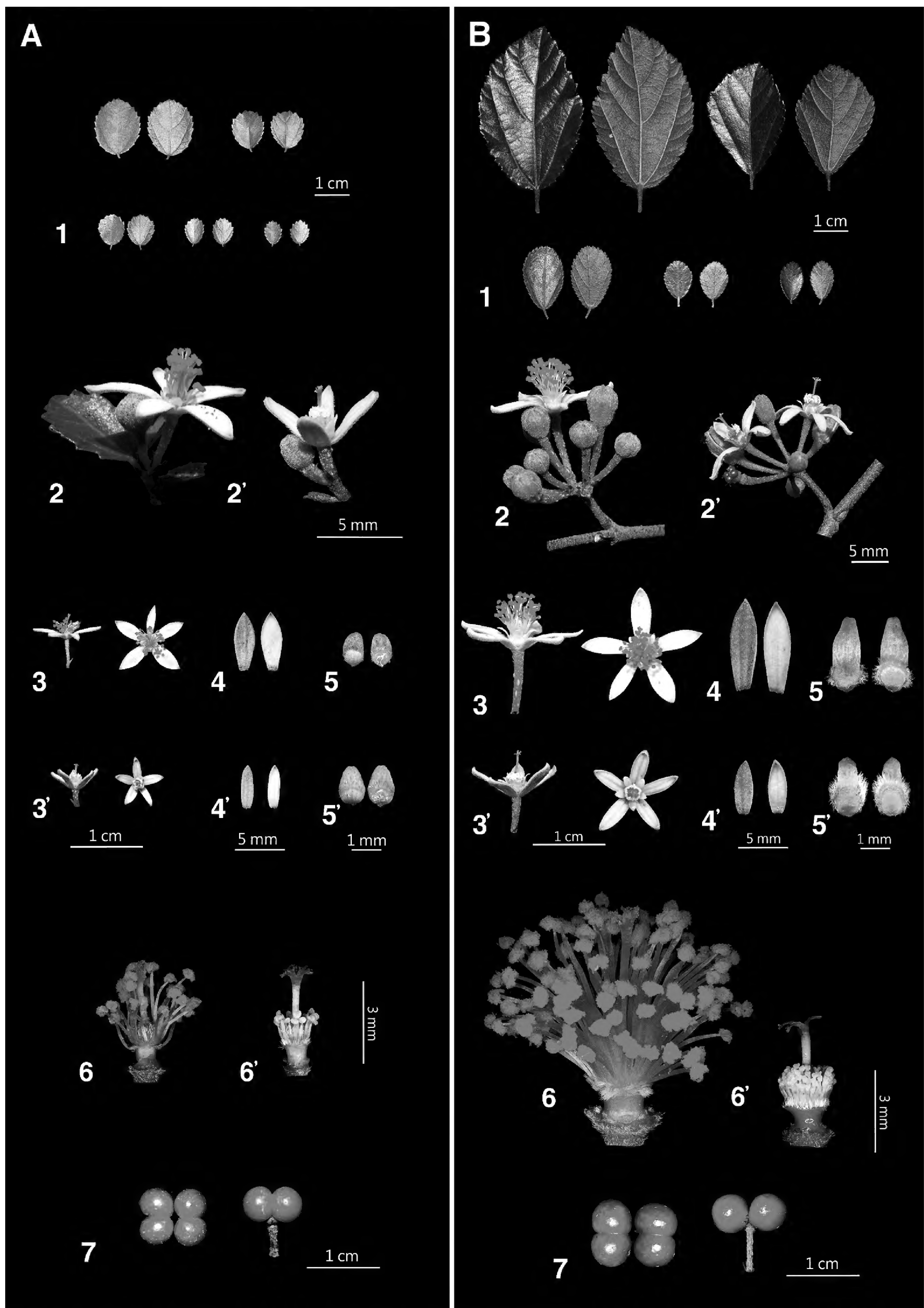


Figure 2. Comparison of morphological characters. **A** *Grewia kentingensis* Y.H.Tseng, Chih Y.Chang & C.Y.Lin **B** *Grewia piscatorum* Hance **1** leaves **2** bisexual inflorescence **2'** female inflorescence **3** bisexual flower **3'** female flower **4** sepal (bisexual) **4'** sepal (female) **5** petal (bisexual) **5'** petal (female) **6** bisexual flower (sepals and petals removed) **6'** female flower (sepals and petals removed) **7** fruit (left: overhead view; right: side view).

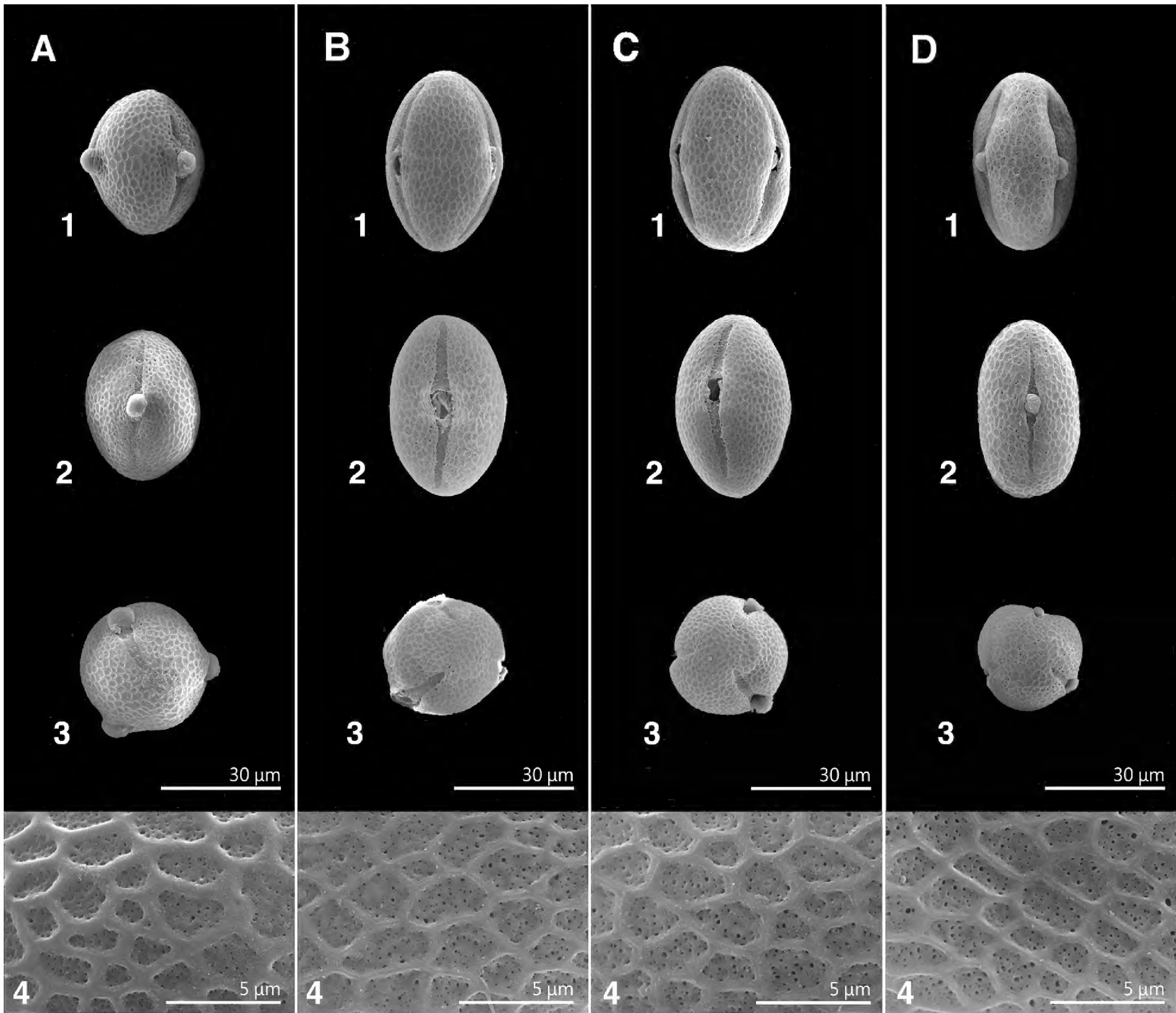


Figure 3. Comparison of pollen morphology of four *Grewia* taxa. **A** *Grewia kentingensis* Y.H.Tseng, Chih Y.Chang & C.Y.Lin **B** *Grewia piscatorium* Hance **C** *Grewia rhombifolia* Kaneh. & Sasaki **D** *Grewia biloba* G. Don var. *biloba* **1** equatorial view **2** colporate view **3** polar view **4** surface sculpture.

0.05) than that in *G. piscatorium* (0.4–0.7 μm), *G. rhombifolia* (0.4–0.7 μm), or *G. biloba* var. *biloba* (0.4–0.7 μm) (Fig. 3, Table 2). In conclusion, *G. kentingensis* pollen can be distinguished from that of other taxa by its shape, smaller polar axis, smaller P/E ratio, smaller lumen size, and wider muri.

Re-evaluation of *Grewia piscatorium* in Kinmen and Lienchiang counties, Taiwan

Grewia piscatorium was described by Hance (1866), who based the name on a collection by Swinhoe made on Lamyet Island (Nanjeih Island) in Fujian Province, China (Swinhoe in Herb. Hance 6527). During our field trip to Kinmen and Lienchiang counties in Taiwan and based on examination of specimens, we found that the *Grewia* in Kinmen and Lienchiang counties closely resembled the type specimen of *G. piscatorium*. Additionally, the *Grewia* populations found in Kinmen and Lienchiang counties are geographically close

to the type locality of *G. piscatorum*; both counties located on islands along the coast of Fujian Province.

In previous studies, the *Grewia* in Kinmen and Lienchiang counties was identified as *G. rhombifolia* (Kuo 2004; Lu 2011). However, we found that this *Grewia* has nearly glabrous leaf surfaces on both sides, with sparse stellate hairs on the veins. Thus, it differs from *G. rhombifolia*, which is characterized by a dense covering of stellate hairs on both leaf surfaces. Hance (1866) stated that *G. piscatorum* has a small leaf blade size. After measuring the type specimen, we determined the leaf blade size to be 0.7–2.5 cm. Nevertheless, based on field observations, we found that leaf blade size varies greatly within an individual plant, differing by leaf position on the branchlet (Fig. 4). On the same branchlet, leaves near the distal end of a branchlet are usually larger, reaching 3–7 cm, whereas leaves near the proximal end of a branchlet are smaller, with a size of 0.5–2 cm. This latter leaf blade size matches that of the type specimen of *G. piscatorum* (Fig. 4). This variation in leaf size has also been found in Bombacoideae (Malvaceae) (Carvalho-Sobrinho et al. 2024). Additionally, such variation in leaf morphology has been observed in *G.*

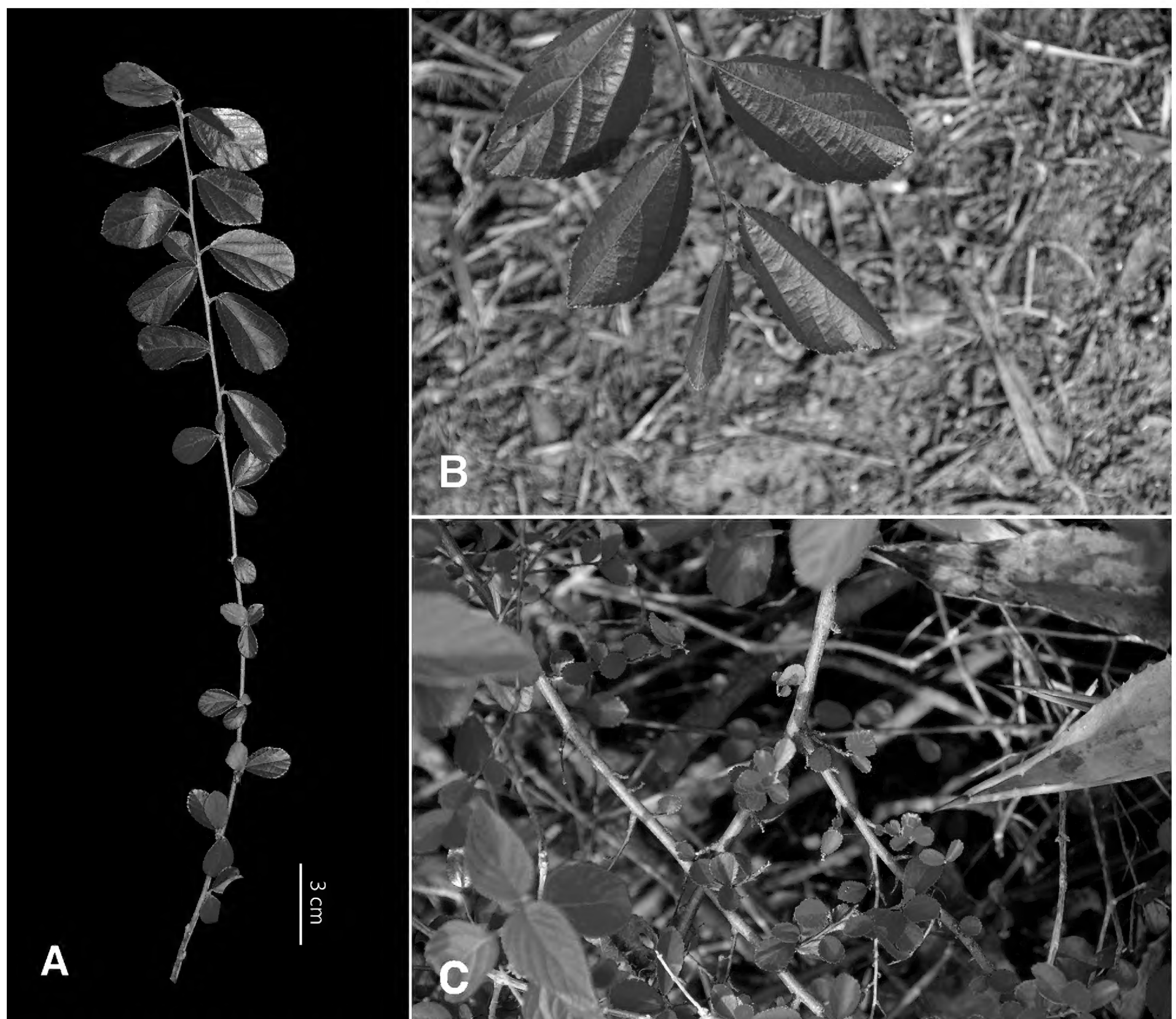


Figure 4. Variation in leaf size of *Grewia piscatorum* Hance. **A** variation in leaf size at different positions on the same branchlet **B** leaves near the distal end of a branchlet **C** leaves near the proximal end of a branchlet.

rhombifolia. Smaller leaf blade forms of *G. rhombifolia* in Taiwan have been identified as *G. piscatorium* (Sasaki 1928; Kanehira 1936; Li 1963; Liu and Lo 1993). In previous studies, leaf blade size was often used for identification (Li 1963; Liu et al. 1988; Liu and Lo 1993; Liu et al. 1998). However, variation in leaf blade size can contribute to overlap in size measurements among different taxa thereby rendering the identification of closely related taxa by this criterion alone challenging. In addition to leaf blade size, other characters such as habit, leaf vestiture, and floral morphology should be considered in comparisons for identification (Table 2).

The leaf blade size in *Grewia kentingensis* is much more consistent, with a leaf blade size of 0.5–1.5 cm. Leaves do not exceed 2 cm, which is significantly different from leaves of *G. piscatorium*. In summary, based on the similarity to the type specimen and description of *G. piscatorium* by Hance (1866), we consider the *Grewia* previously identified as *G. rhombifolia* in Kinmen and Lienchiang counties to be *G. piscatorium*.

Comparison of the distributions of *Grewia kentingensis* and *G. piscatorium*

Grewia kentingensis is only found along the eastern coastline of Hengchun Peninsula. This species grows on elevated coral reefs and open coastal grasslands with intense sunlight. By contrast, *G. piscatorium* is found in coastal hills or islands in Fujian and Hainan provinces in China (Chun and Chang 1965; Chang 1987; Chang 1989; Tang et al. 2007). In Taiwan, *G. piscatorium* is only found in Kinmen and Lienchiang counties (Fig. 5).

Key to *Grewia* in Taiwan modified from Liu and Lo (1993) and Chang et al. (2018)

- 1a Leaf bases cordate to rounded, usually oblique; inflorescences axillary; flowers bisexual only; sepals reflexed; fruits unlobed or 2-lobed2
- 2a Abaxial surface of leaves tomentose; petals and stamens turn from yellow to orange before withering; fruit surface tomentose***G. eriocarpa***
- 2b Abaxial surface of leaves nearly glabrous; petals and stamens turn from yellow to red before withering; fruit surface pubescent***G. tiliifolia***
- 1b Leaf bases cuneate, obtuse to rounded, seldom oblique; inflorescences terminal or rarely axillary; flowers unisexual or bisexual; sepals erect or slightly reflexed; fruits usually 2- to 4-lobed3
- 3a Procumbent shrubs; leaf blade length < 2 cm; gynodioecious; inflorescences terminal, 1–3(4–6) flowers per peduncle; stamens < 40 per flower***G. kentingensis***
- 3b Trees or erect to ascending shrubs; leaf blade length often > 2 cm; tri-oecious; inflorescences leaf-opposed, 4–15 flowers per peduncle, rarely axillary; stamens > 50 per flower.....4
- 4a Leaves densely covered with stellate hairs above and below....***G. rhombifolia***
- 4b Leaves surfaces nearly glabrous above and below5
- 5a Small trees ca. 3–5 m tall; leaf blades ovate to elliptic, sometimes rhomboid-ovate, maximum length > 10 cm.....***G. biloba* var. *biloba***
- 5b Erect to ascending shrubs ca. 1–2 m tall; leaf blades elliptic, obovate, or ovate to rhomboid-ovate, maximum length < 10 cm***G. piscatorium***

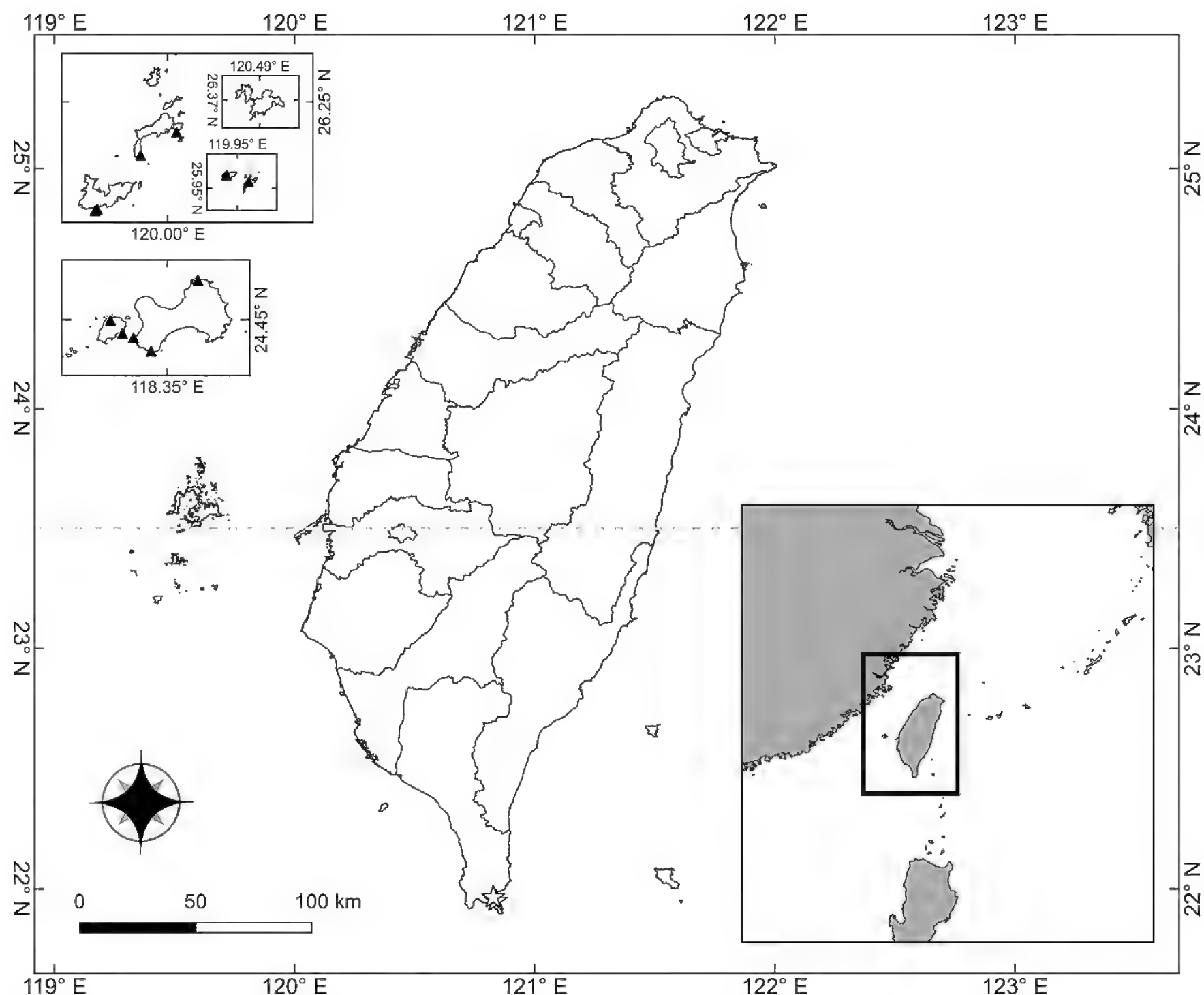


Figure 5. Distribution map of *Grewia kentingensis* Y.H.Tseng, Chih Y.Chang & C.Y.Lin (white star) and *G. piscatorum* Hance (black triangle) in Taiwan.

Taxonomic treatment

Grewia kentingensis Y.H.Tseng, Chih Y.Chang & C.Y.Lin, sp. nov.

urn:lsid:ipni.org:names:77357855-1

Figs 1A, 2A, 3A, 6, 7, 8

Diagnosis. *Grewia kentingensis* is similar to *G. piscatorum* but can be distinguished by its procumbent (vs. erect to ascending) habit, smaller leaf size, serrate (vs. biserrulate) leaf margin, terminal (vs. often leaf-opposed) inflorescences, gynodioecious (vs. trioecious) breeding system, smaller flowers, fewer stamens, smaller fruits, and smaller pollen grains.

Type. TAIWAN. Pingtung County • Hengchun Township, Shedding Formosan Sika Deer Restoration Area, 154 m alt., 21°57'53.0"N, 120°49'39.2"E, 26 June 2024, C. Y. Lin et al. 93 (holotype: TCF; isotype: TNM).

Description. Procumbent shrubs to ca. 5 cm tall, stems rooting at the nodes; young branchlets puberulent, older branchlets nearly glabrous. Leaf blades broadly elliptic to elliptic, 0.4–1.6 cm long, 0.3–1.3 cm wide, apex rounded to obtuse, base cuneate to rounded, 3-nerved, margin serrate, nearly glabrous, stellate hairs sparsely distributed along the veins on both surfaces; petioles

0.4–1.3(–1.7) mm long, stellate hairs sparse; stipules linear, 0.4–1.2 mm long. Inflorescences terminal, cymose or flowers solitary; peduncles 0.7–2.7 mm long, 1 to 3(4 to 6) flowers, pedicels 0.9–4.9 mm long; bracts linear, 0.7–1.4(–1.8) mm long. Flowers bisexual or functionally unisexual (female), bisexual flowers 7.2–11.7 mm diam., female flowers 5.2–7.8 mm diam. Sepals (3)4 to 5, narrowly oblong to oblong, bisexual flowers 4.5–6.0 mm long, 1.4–2.3 mm wide; female flowers 3.2–4.8 mm long, 0.9–1.9 mm wide, apex acute, abaxial surface yellowish green, stellate-pubescent, adaxial surface white, glabrous. Petals (3)4 to 5, oblong to ovate, apex rounded, bisexual flowers 1.1–1.5 mm long, 0.6–0.9 mm wide, female flowers 1.2–1.6 mm long, 0.7–0.9 mm wide; nectaries present at the base of adaxial surface, 0.6–0.9 mm diam., surrounded by ciliate hairs. Androgynophore cylindrical, bisexual flowers 0.7–0.9 mm long; female flowers 0.8–0.9 mm long, glabrous, ciliate hairs only at the apex. Ovary globose to oblate, pubescent, bisexual flowers 0.8–1.0 mm diam.; female flowers 0.8–1.0 mm diam. Bisexual flowers with stamens 25 to 33, filaments white, glabrous, 1.2–3.2 mm long, anthers dehiscing longitudinally; style (1.8–)2.3–2.7 mm long, glabrous, stigma 4-lobed, each lobe dentate at apex. Female flowers with 15–20 stamens, filaments white, glabrous, 0.6–1.1 mm long, anthers white, always indehiscent; style 1.3–2.2 mm long, glabrous, stigma 4-lobed, each lobe dentate at apex. Fruits drupaceous, usually 4-lobed, fruit lobe 4.1–5.2 mm diam., globose, puberulent to nearly glabrous, red when mature.

Phenology. Flowering from May to August and fruiting from June to September.

Distribution and habitat. The species is endemic to Taiwan. *Grewia kentingensis* is sparsely distributed only on the elevated coral reefs and the coastal open grasslands at 50–200 m alt. along the eastern coastline of the Hengchun Peninsula. Commonly associated species include *Maytenus diversifolia* (Maxim.) Ding Hou (Celastraceae), *Pandanus odorifer* (Forssk.) Kuntze. (Pandaceae), *Phoenix loureiroi* Kunth var. *loueiroi* (Palmae), *Rostellularia hayatae* (Yamam.) S.S.Ying (Acanthaceae), *Galactia tashiroi* Maxim. (Fabaceae), and *Cirsium albescens* Kitam. (Compositae).

Chinese name. kě-n-dīng-bǔ-yú-mù (墾丁捕魚木)

Etymology. The species epithet *keningensis* refers to the type locality of Kenting in Hengchun Peninsula, Pingtung County, Taiwan.

Palynology. Pollens grains are tricolporate, subprolate to prolate, $35.8\text{--}41.4 \times 24.1\text{--}33.4 \mu\text{m}$. Exine reticulate, with muri $0.6\text{--}0.8 \mu\text{m}$ wide and lumen $1.0\text{--}2.9 \mu\text{m}$. Perforations present in the lumen, $0.04\text{--}0.24 \mu\text{m}$.

Conservation status. *Grewia kentingensis* has an extremely limited distribution on the Hengchun Peninsula and is known from 12 collections representing three populations. It has a geographic range in the form of an estimated EOO of 8 km^2 (adjusted upward from 1.423 km^2 following IUCN 2024) and an AOO of 8 km^2 . Even though the distribution of the species is located within the areas of Kenting National Park, its habitat is threatened by grazing, wildfires, and invasive plant species (*Cuscuta campestris* Yunck., *Stachytarpheta jamaicensis* (L.) Vahl, and *Bidens pilosa* var. *radiata* (Sch. Bip.) J.A. Schmidt). Given these ongoing threats, we infer a continuing decline in the area, extent and quality of habitat. With respect to the most serious plausible threat of wildfire, the three occurrences represent one location, which falls within the limits for “Critically Endangered” status. *Grewia kentingensis* is therefore preliminarily assessed as “Critically Endangered” [CR B1ab(iii)+2ab(iii)] in accordance with the IUCN Red

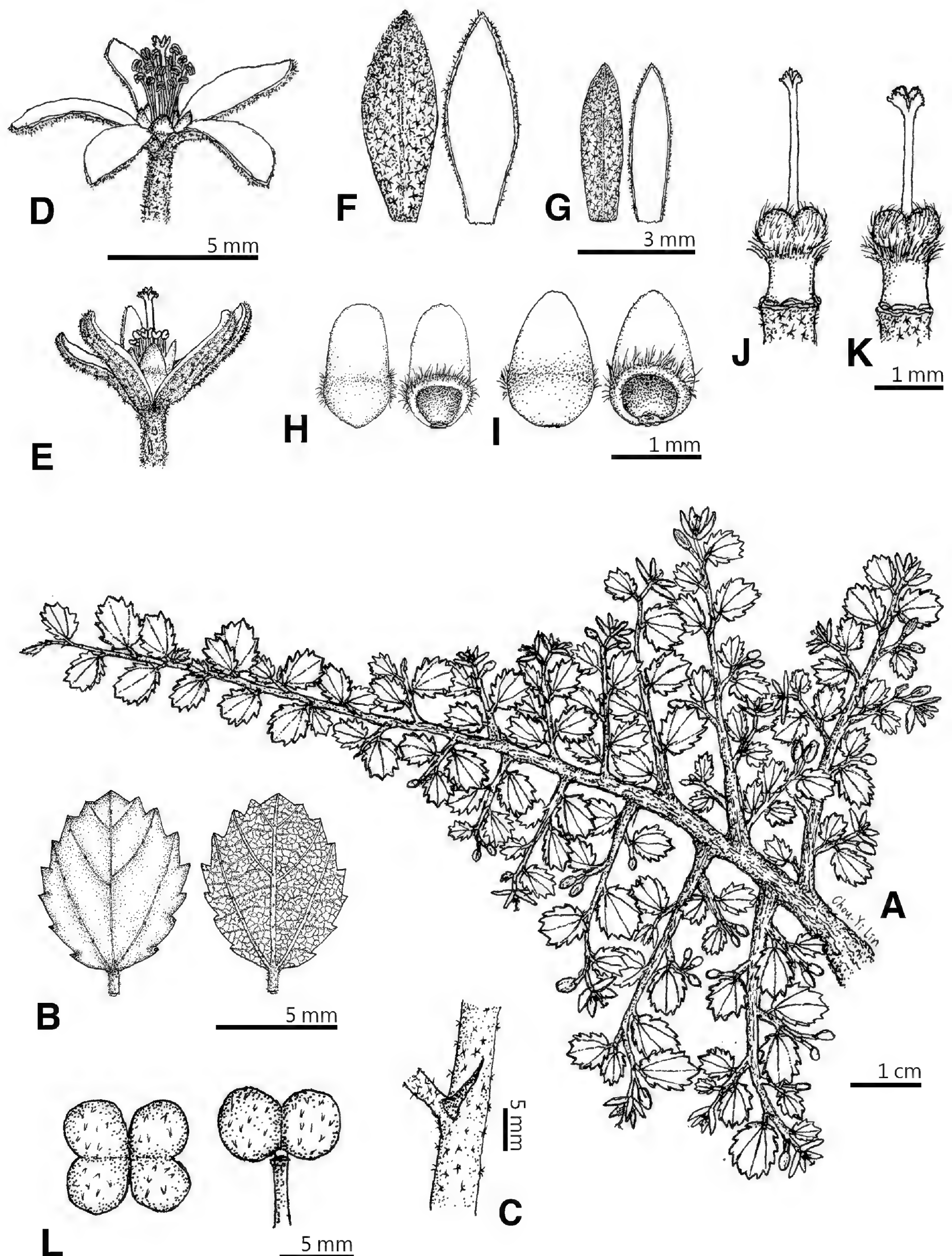


Figure 6. *Grewia kentingensis* Y.H.Tseng, Chih Y.Chang & C.Y.Lin. **A** habit **B** leaves **C** stipule **D** bisexual flower **E** female flower **F** sepals (bisexual) **G** sepals (female) **H** petals (bisexual) **I** petals (female) **J** gynoecium (bisexual) **K** gynoecium (female) **L** fruit (left: overhead view; right: lateral view).

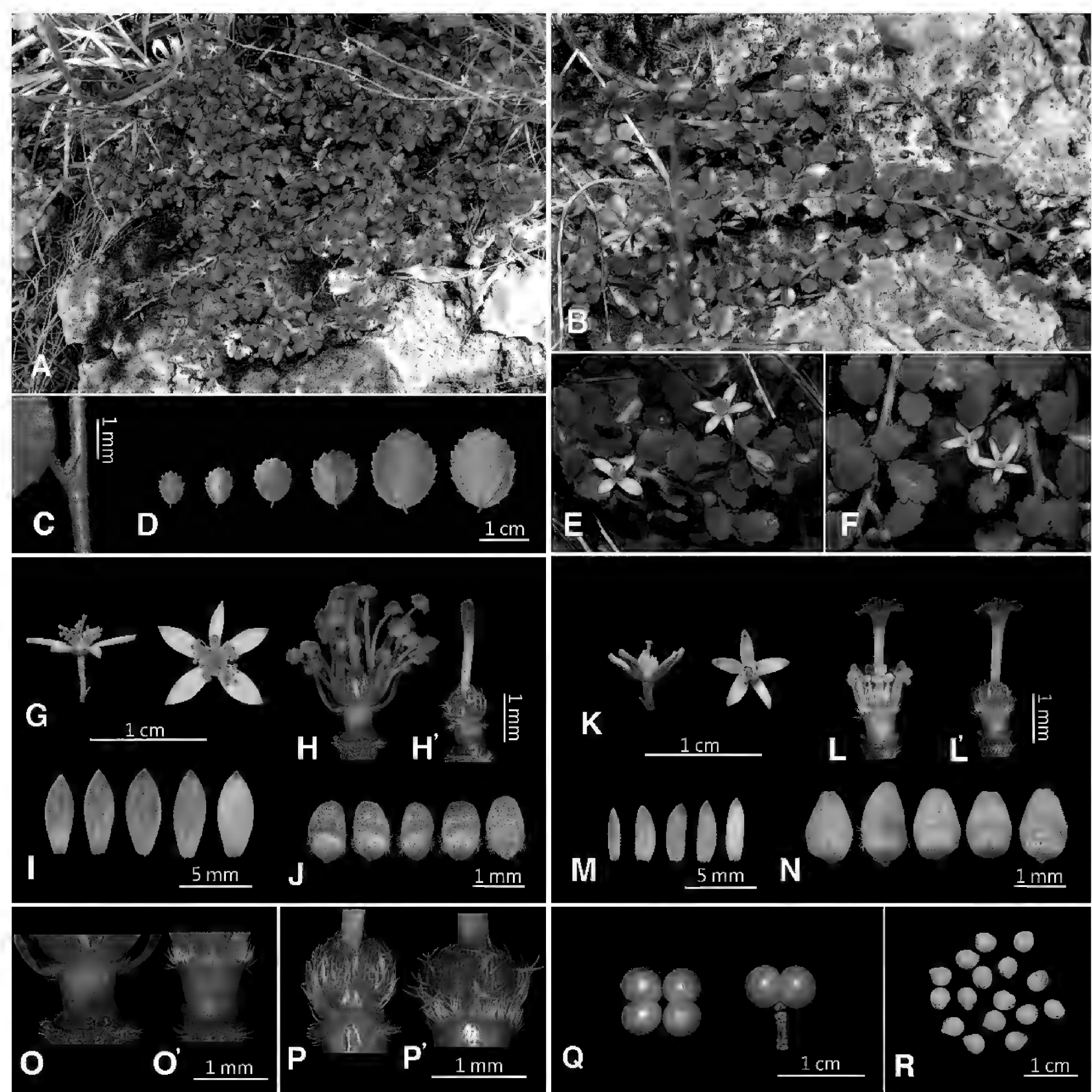


Figure 7. *Grewia kentingensis* Y.H.Tseng, Chih Y.Chang & C.Y.Lin. **A** habitat **B** habit **C** stipule **D** leaf blade variation **E** inflorescence (bisexual) **F** inflorescence (female) **G** bisexual flowers **H** bisexual flower (sepals and petals removed), **H'** gynoecium (bisexual) **I** sepals (bisexual) **J** petals (bisexual) **K** female flowers **L** female flower (sepals and petals removed), **L'** gynoecium (female) **M** sepals (female) **N** petals (female) **O** androgynophore (bisexual) **O'** androgynophore (female) **P** ovary (bisexual) **P'** ovary (female) **Q** fruit (left: overhead view; right: lateral view) **R** pyrenes.

List Categories and Criteria (IUCN 2024). The above analysis is based on the specimens cited and georeferenced as shown in Table 4.

Specimens examined. **TAIWAN. Pingtung County** • Fongchueisha, 28 Jun 1988, *T. C. Huang & S. F. Huang* 13542 (TAI) • Ibid., 23 Jul 2013, *K. C. Chang* 4893, 4894 (CHIA) • Ibid., 29 Mar 2015, *C. Y. Chang & C. H. Liu* 397 (TNM) • Ibid., 3 May 2024, *C. Y. Lin et al.* 69 (TCF) • Longzaipu, 6 Sep 2008, *P. F. Lu* 16921 (TAIF) • Ibid., 17 Sep 2008, *T. C. Hsu* 1743 (TAIF) • Ibid., 23 Jul 2013, *C. M. Wang et al.* 15470 (TNM) • Ibid., 14 Aug 2013, *C. F. Chen* 4697 (TAIF) • Ibid., 12 Apr 2014, *C. Y. Chang* 30 (PPI) • Sheding, 12 Aug 1995, *Y. H. Yu* 7968 (TAIF) • Sheding Formosan Sika Deer Restoration Area, 15 Jan 2021, *C. Y. Chang et al.* 3236 (TNM).

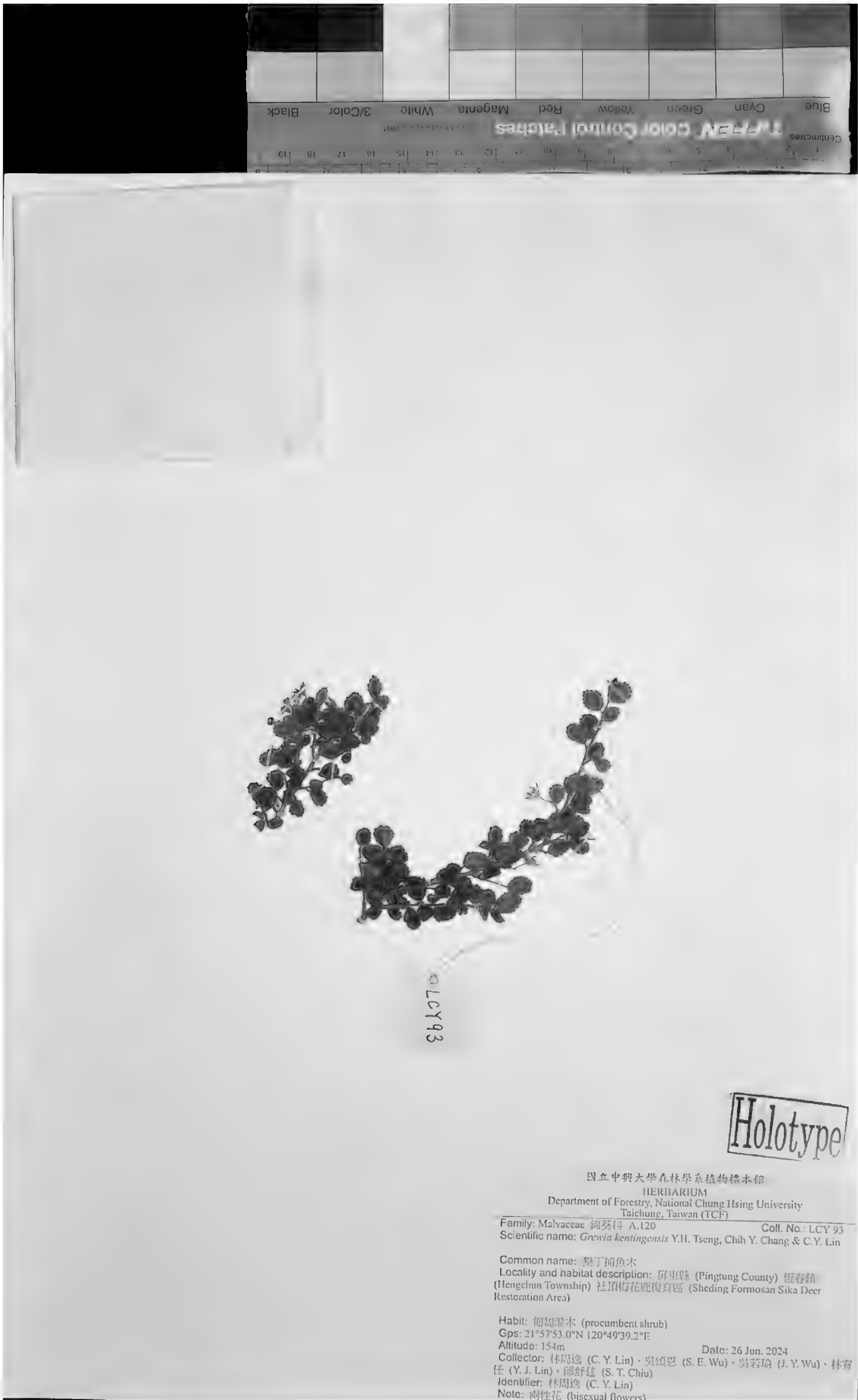


Figure 8. Holotype of *Grewia kentingensis* Y.H.Tseng, Chih Y.Chang & C.Y.Lin, C. Y. Lin et al. 93 (TCF).

Table 4. Specimens and coordinates used for the analysis of the conservation status.

Latitude / Longitude	Specimens
21°56'52.3"N, 120°50'18.3"E	T. C. Huang & S. F. Huang 13542; K. C. Chang 4893, 4894; C. Y. Chang & C. H. Liu 397; C. Y. Lin et al. 69
21°56'31.1"N, 120°49'37.9"E	P. F. Lu 16921; T. C. Hsu 1743; C. M. Wang et al. 15470; C. F. Chen 4697; C. Y. Chang 30
21°57'53.0"N, 120°49'39.2"E	Y. H. Yu 7968; C. Y. Chang et al. 3236; C. Y. Lin et al. 93

***Grewia piscatorum* Hance in Ann. Sci. Nat., Bot., sér. 5, 5. 208. 1866.**
Figs 1B, 2B, 3B, 4, 9

Type. CHINA • Fokien province: Lamyet island, 1860, *Swinhoe* s.n. in Herb. Hance 6527 (lectotype, designated here: BM [barcode BM000795018 as image!]; isolectotype, K [barcode K000686751 as image!]).

Notes. In the protologue, Hance (1866) cited a Swinhoe collection that he assigned one of his own collection numbers (“Herb. propr., no. 6527”). Hance (1866) did not unequivocally state that he based the name on a single specimen and since there are duplicates of this Hance number in BM (BM000795018) (Fig. 9) and K (K000686751), we designate a lectotype for *Grewia piscatorum*. The sheet selected is in Hance’s herbarium (BM), and it is the duplicate with relatively more leaves and flowers.

Description. Erect to ascending shrubs, ca. 1–2 m tall; young branchlets scabrous, older branchlets nearly glabrous. Leaf blades elliptic, obovate, ovate to rhomboid-ovate, 0.7–7.8 cm long, 0.5–5.5 cm wide, apex acute, obtuse to rounded, base cuneate to obtuse, 3-nerved, margin serrulate to biserrulate, nearly glabrous, stellate hairs sparsely distributed along the veins on both surfaces; petioles 1.3–13.4 mm, sparsely stellate hairy; stipules linear, 2.4–5.1 mm long. Inflorescences leaf-opposed or rarely axillary, umbellate; peduncles 3.1–17.2 mm long, 6 to 15 flowers, pedicels 3.5–8.8 mm long; bracts linear, 1.4–2.6(–3.0) mm long. Flowers bisexual, functionally unisexual male or functionally unisexual female; bisexual flowers 14.8–18.5(–20.2) mm diam.; male flowers 14.2–18.8 mm diam.; female flowers 9.4–14.6 mm diam. Sepals (4)5(6), narrowly oblong to oblong, bisexual flowers 7.5–10.8 mm long, 2.4–4.1 mm wide, male flowers 7.3–8.4 mm long, 2.1–3.0 mm wide, female flowers 4.5–5.7 mm long, 1.4–2.0 mm wide, apex acute, abaxial surface yellowish green, stellate–pubescent, adaxial surface white, glabrous. Petals (4)5(6), oblong to ovate, apex rounded, bisexual flowers 2.2–3.3 mm long, 0.9–1.2 mm wide, male flowers 2.1–2.9 mm long, 0.9–1.2 mm wide, female flowers 1.5–2.5 mm long, 0.6–1.0 mm wide; nectaries present at the base of adaxial surface, 0.8–1.3 mm diam., surrounded by ciliate hairs. Androgynophore cylindrical, bisexual flowers 1.1–1.6 mm long; male flowers 1.1–1.5 mm long; female flowers 0.9–1.2 mm long, glabrous, ciliate hairs only at the apex. Ovary globose to oblate, pubescent, bisexual flowers 1.2–1.4 mm diam.; male flowers 1.2–1.5 mm diam.; female flowers 0.9–1.3 mm diam. Bisexual flowers with 103–118 stamens, filaments white, glabrous, 2.4–6.8 mm long, anthers dehiscing longitudinally; style 3.6–5.4 mm long, glabrous, stigma 4-lobed, each lobe dentate at apex. Male flowers with 70–88 stamens, filaments white, glabrous, 2.1–4.7 mm long, anthers dehiscing longitudinally; style 3.1–4.1 mm long, glabrous, stigma 4-lobed, each lobe dentate at apex. Female flowers with 58–102 stamens, filaments white, glabrous, 0.5–1.5 mm long, anthers white, always inde-



Figure 9. Lectotype of *Grewia piscatorum* Hance, Swinhoe s.n. in Herb. Hance 6527 (BM000795018).

hiscent; style 1.8–2.6 mm long, glabrous, stigma 4-lobed, each lobe dentate at apex. Fruits drupaceous, usually 4-lobed, fruit lobe 4.4–6.4 mm diam., globose, puberulent to nearly glabrous, red when mature.

Phenology. Flowering from May to September and fruiting from June to October.

Distribution and habitat. Distributed in Fujian Province and Hainan Province in China and in Taiwan on the coastal areas of Kinmen and Lienchiang Counties.

Palynology. Pollens grains are tricolporate, prolate, $42.8\text{--}47.8 \times 27.4\text{--}31.0 \mu\text{m}$. The exine is reticulate, with muri $0.4\text{--}0.7 \mu\text{m}$ wide and lumen size $1.1\text{--}4.0 \mu\text{m}$. Perforations present in the lumen, $0.04\text{--}0.26 \mu\text{m}$.

Specimens examined. **CHINA. Fujian Province** • Fuzhou City, Tangyu, 24 May 1964, *T. H. Chen* 493 (AU) • Fuzhou City, Yemayu, 31 May 1964, *T. H. Chen* 515 (AU); Fuzhou City, Zhuyu, 17 May 1963, *T. H. Chen* 1561 (AU) • Xiamen City, Nanputuo, 20 Jul 1954, *J. C. Lin* 3857 (AU). **Hainan Province** • Dongfang City, seacoast of Dingjiao village, 20 Aug 1936, *S. K. Lau* 27727, 27730 (IBSC); Sanya City, Xigu island, 3 Aug 2018, *H. L. Hou* 92038 (AU). **TAIWAN. Kinmen County** • Brave Fortress, 24 Jun 2017, *S. W. Chung* 12988 (TAIF) • Caicuo Trail, 2 Jun 2019, *C. T. Lu et al.* 2515 (TNM) • Doumen to Taiwu Mountain, 22 Jul 2007, *C. M. Wang* 10497 (TNM) • Fengshang, 20 May 2009, *J. S. Shiu & Y. L. Hsueh* H315 (CHIA) • General's Spring, 28 May 2023, *C. Y. Lin* 22 (TCF) • Jiugong Pier, 25 May 2002, *C. M. Wang* 5611 (TNM) • Ibid., 7 Sep 2021, *C. Y. Chang et al.* 3539 (TNM) Ibid., 28 May 2023, *C. Y. Lin* 17 (TCF) • Jiugong Tunnel to shore-line road, 28 May 2023, *C. Y. Lin* 20 (TCF) • Liaoluo, 22 May 2017, *T. C. Hsu* 9131 (TAIF) • L36 Fortress, 25 May 2024, *C. Y. Lin et al.* 85 (TCF) • Mashan Observation Post, 26 Aug 2015, *C. Y. Chang et al.* 724 (TCF, TNM) • Ibid., 29 May 2023, *C. Y. Lin* 24 (TCF) • Paichushan to Huotou, 10 Jun 1999, *S. T. Chiu* 5386 (TNM) • Qilinshan, 25 May 2024, *C. Y. Lin et al.* 86 (TCF) • Qingyuan Lake, 9 Aug 2002, *I. H. Chiang* 120 (TAI) • Shuitou Pier, 28 May 2023, *C. Y. Lin* 21 (TCF) • Taiwu Mountain, 27 Jul 2005, *K. C. Chen* s.n. (TAIF) • Ibid., 15 Jun 2006, *C. H. Chen* 7283 (TNM) • Ibid., 4 Jun 2016, *S. W. Chung* 12534 (TAIF) • Taiwu nursery, 22 Jul 2007, *C. M. Wang* 10519 (TNM) • Tashan, 14–17 May 2010, *F. Y. Lu et al.* H2794 (CHIA) • Tzuhu, 25 Jul 2005, *K. C. Chen* s.n. (TAIF) • Tzuti, 25 Jul 2005, *K. C. Chen* s.n. (TAIF) • Wuhu Mountain, 13–16 Jul 2009, *F. Y. Lu et al.* 1015 (CHIA) • Xiyuan beach to Chengkung Fortress, 29 May 2023, *C. Y. Lin* 23 (TCF) • Zhaishan Tunnel, 25 May 2024, *C. Y. Lin* 80 (TCF). **Lienchiang County** • Beihai Tunnel, 19 Jul 2008, *C. M. Wang* 12180 (TNM) • Chengkungshan, 27 Aug 2007, *T. W. Hsu* 13020 (TAIE) • Chiukueishan, 27 Aug 2001, *Y. L. Huang et al.* 816 (TAI) • Daping to lighthouse, 30 May 1994, *T. Y. Liu & H. L. Ho* 653 (TNM) • Dapu Inscription, 9 Sep 2007, *C. M. Wang & C. P. Lu* 10690 (TNM) • Fuzheng, 30 Jul 1999, *S. H. Su* 624 (TAI) • Jinsha, 1 Jul 1999, *S. H. Su* 352 (TAI) • Dawo Mountain, 16 Sept 2014, *S. W. Chung* 11782 (TAIF) • Kunqiu Trail, 17 Oct 2017, *C. Y. Chang* 1473 (TCF, TNM) • Leishan, 29 Aug 2007, *T. W. Hsu* 13079 (TAIE).

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Additional information

Conflict of interest

The authors have declared that no competing interests exist.

Ethical statement

No ethical statement was reported.

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Author contributions

Conceptualization: YHT, CYC, CMW, CYL. Data curation: CYL. Formal analysis: CYL. Funding acquisition: YHT. Investigation: CYC, CYL. Methodology: CYL, CYC. Project administration: YHT, CYL. Resources: CMW, CYL, CYC, HYT. Software: HYT. Supervision: YHT, HYT. Validation: CMW, CYL. Visualization: CYL. Writing – original draft: CYL. Writing – review and editing: CYC, CMW, YHT, HYT, CYL.

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Data availability

All of the data that support the findings of this study are available in the main text.

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